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THE RELATION OF THE PORTO RICO
AGRICULTURAL EXPERIMENT STATION (MAYAGUEZ, P. R.)
TO THE AGRICULTURE OF PORTO RICO-1904-1930.
By T. B. McClelland, Director.

In April, 1930, Mr. D. W. May retired from the directorship of the Porto Rico Agricultural Experiment Station after 26 years in charge. Many changes occurred in the agriculture of the Island during that period. It may be of interest to note at the present time, ways in which the work of the station influenced or brought about some of these changes.

The mosaic disease is the limiting factor in cane-growing in certain districts of Porto Rico. In 1919, owing to the depressed outlook for cane production and the crisis produced by the ravages of the mosaic disease, the station imported some barrels of cuttings of Uba Natal, or Japanese, cane which was rapidly propagated and distributed all over the Island. The attitude of the sugar growers in respect to this timely introduction was clearly shown by a memorial presented by them "in testimony of gratitude" stating that by the introduction of Uba cane "the industry was thus saved from destruction." Uba cane has thus played a very important rôle in the economic history of the Island. Uba cane undoubtedly will be grown for forage after it has been supplanted by superior cane varieties for sugar.

Later the station imported better varieties which were immune to mosaic, namely, P. O. J. 2725 in June, 1923, and P. O. J. 2878 in March, 1927. P. O. J. 2725 is grown extensively by several sugar centrals and is considered one of the more important varieties in Porto Rico. P. O. J. 2878 was imported directly from Java by this station. Through information disseminated on means of propagation, P. O. J. 2878 is already being planted on several thousands of acres. This station also imported S. C. 12/4, which is grown on thousands of acres, in some districts to the exclusion of any other cane variety.

A number of cane varieties, immune or highly resistant to mosaic, have been bred at the station. These include Mayaguez 3, 7, 28, 42 and 49. Some of these are expected to figure prominently in the future of Porto Rican cane growing.

For years this station has conducted fertilizer experiments with coffee and has shown that suitable fertilization of coffee gives highly profitable increases in production. It has shown that potash is the element which affects most largely the yield of coffee and that a lack of this element in sufficient amount greatly limits production. The station has also done work in relation to coffee pruning and shading. Many varieties of coffee have been imported, tested and distributed. Among these, Excel coffee is of outstanding merit.

Vanilla planifolia was imported by the station in 1909. (An earlier importation had been made by a private citizen, but no attempt had been made toward commercial development.) Vanilla growing was tested, was shown to be profitable, and cuttings were distributed. One of the recipients, a coffee planter, sold one crop from approximately six acres for over \$13,000.

Since 1917 this station has maintained an office in San Juan devoted solely to the interests of fruit growers. Through it they have received unremitting help in meeting their various problems. The two principal cover crops planted in the citrus groves to-day, Crotalaria saltiana and Tephrosia candida, were imported, tested and distributed by this station. For some years the station has endeavored to develop a scab-resistant grapefruit of desirable market quality. Trees of the second generation of a Duncan-Triumph cross are now being grown. Of approximately 50,000 seedlings there remain less than 400 which as yet have failed to show scab susceptibility.

Studies made by the station showed how carbonate of lime injuriously affects^{the} mineral nutrition of such plants as rice and pineapples, and the cause of pineapple chlorosis was determined. These investigations enabled the station to inform planters as to whether certain soils were favorable or unfavorable for growing pineapples. Many planters have profited from this discovery and many thousands of dollars have been saved to them through advice given them by this station, as otherwise lands entirely unsuited for growing pineapples would have been planted to this crop.

Many valuable root crops have been imported, tested and distributed by this station. The Key West sweet potato variety was imported and found to be the most productive of the many varieties tested. It was widely distributed and now is to be found in all parts of the Island. This variety has produced more than 15 tons of tubers per acre. Dasheens were imported from Trinidad and elsewhere in the early days of the station's existence and were later distributed throughout the Island. These form at present an important source of food for the people, as this is an enormously productive crop. The Penang taro, a very superior variety totally distinct from the other taros found in Porto Rico, was imported and distributed by this station. Its culture here has been highly successful as shown both by reports of this station and insular agricultural agencies.

Many miscellaneous trees and plants of promise for Porto Rico have been imported, and the arboretum has been termed "the best grown, identified and representative arboretum in tropical America." The station has actively imported, bred and distributed various ornamentals. Perhaps the most striking ornamental imported and distributed by this station is the amaranth purple Bougainvillea commonly referred to as red or crimson which is to be found throughout the Island. Many new varieties of hibiscus have been developed at this station, and these are now to be seen throughout the Island.

The heavy losses of avocado trees in certain localities were shown to be due to a strain of *Phytophthora* closely resembling *Phytophthora cinnamomi*. The knowledge of the cause of this high mortality in avocados enables the station to advise planters as to where avocados should or should not be planted.

The causal organism of the coconut bud rot disease was shown to be *Phytophthora palmivora*, and measures for combating it were recommended.

The station since its establishment has taken a very active interest in the improvement of the live stock industry. Cattle of improved breeds have been imported and distributed. Free service has been given. The effect of the station's endeavors in this line has been widespread.

The station built the first silo in Porto Rico in 1908. Many others have followed this example.

The first tank in the Island for dipping cattle was built by the station, and as a result of the active propaganda carried on there were about 50 dipping tanks located in various sections of the Island ten years ago and there are many more at present. The benefits arising here have been immeasurable.

The parasitologists of this station have reported for the first time over 80 species of the internal and external parasites of domestic animals, including poultry, in Porto Rico. Several of these because of their rarity are only of interest to scientists. However, many of them have an important bearing on the success of raising live stock in Porto Rico. The life history of the kidney worm, *Stephanurus dentatus*, of swine has been worked out at this station. The intermediate host of the liver fluke, of cattle and goats in Porto Rico, has been found and control methods have been worked out. This finding has already enabled one central alone to reduce its losses from this disease each year in one district from an average of 20 work bulls to 1 or 2. Control measures for stomach worms and nodular worms in cattle have been worked out for Porto Rican conditions. A treatment for one type of Texas fever has been found. Systematic examinations of the carcasses of 100 cattle, 100 goats and 200 swine have been made at

the local abattoir to determine the species of parasite, the percentage infested and the importance of the parasite collected. This station now has a record of over 900 examinations of feces, blood and skin scrapings from various parts of the Island indicating the species, the degree of infection and the distribution of various parasitic infestations.

In addition to the importation of cattle, and studies of their parasites and means for combating the latter, the question of cattle feeds has received due attention. Both the elephant and the Guatemala grass, each producing nearly twice the amount of forage as either Guinea or Para grass, were imported and distributed by this station. Were it not for these two grasses the present milk supply of Porto Rico would be much less than it is to-day, as these grasses are mainstays of the dairy industry. In 1912 molasses grass (Melinis minutiflora) was imported by this station, and in the report for that year it was pronounced "the most productive grass tried here so far on lowland." The station has imported and distributed Java grass, Polytrias praemorsa, in Java considered the best grass for grazing. This is also a beautiful lawn grass.

In July 1908 this station imported 5 nuclei of Italian bees, and from these the honey industry in this Island largely developed. In the period from July, 1919, to May, 1920, beeswax and honey were exported from Porto Rico to the value of \$450,607.

It has been debated whether man or insects will finally triumph. Those of us who have lived in more or less intimate association with the cockroach, the ant, the termite, the changa, the white grub, and the hosts of other tropical insects, are not ready to admit that the insects have been vanquished as yet. We welcome any weapons with which to combat them. The humble toad has come to our rescue, although not inspired by altruistic motives. The giant toads—Bufo marinus—were introduced ten years ago from Barbados by this station, and subsequently were shipped to all parts of the Island in lots varying from 10 to 1,000. They may be seen now at night in the fields in great numbers. Examinations of the stomach contents have shown that they are destroying changas, white grubs, ants, cockroaches and numerous other harmful insects, and so perform an important service in insect control.

An introduction of more recent date than that of the toad, namely in 1929, and one which may prove eventually an important source of food supply, was that of the edible frog, or "mountain chicken," Leptodactylus pentadactylus, from Dominica. Although none of these has been captured since they were turned loose at the Cartagena Lagoon, the people who live nearby report them to be broadcasting their programs on the air when atmospheric conditions are favorable.

A review of certain phases of the station's activities and of the agriculture of the Island during the period under discussion has been prepared for us by Mr. May. It follows:

IN RETROSPECT
By D. W. May

A review of 26 years of the station's work during which time the writer was in charge, that is, from May, 1904, to May, 1930, may not only show the results attained in the way of improved agricultural practice but serve as a guide to future experiments that may promise returns.

In 1904 agriculture in the Island was at a low ebb. Coffee, a leading product, was cheap in price. Long continued cropping from a depleted soil had resulted in low production. Sugar was giving low yields due to lack of rotation in the fields and poor cultivation, and returns were diminishing from growing the same varieties—Otaheite and Cristalina—on the same soil. The fruit industry was represented by the shipment of some wild oranges mainly from Mayaguez. Agricultural labor was very cheap, 50 cents per day being the wage for an able-bodied man. Agricultural machinery was lacking, the wooden plow and the plantation pick hoe being much in evidence.

Cattle had been bred indiscriminately without any definite object in view; horses were small and without strength for field work; pigs were of the razor-back type; chickens, the game kind,—prowess for fighting, the first consideration.

The experiment station was the only institution or organization in existence at that time to attack the problems confronting the planters. It alone was established to experiment, try out, condemn or recommend, teach and apply the findings.

The farm selected for the experiment station was typical of the Island at that time. Fences were gone, drains on the low lands filled up, high lands gullied, timber cut off for charcoal making, the roof of the sugar mill to be used for offices and laboratories fallen in.

The problems before the station were to establish itself, to introduce improved economic plants and live stock, to improve those then on the Island, to disseminate information, a rather wide program for the sum available.

The greatest possible good for the least expenditure seemed to lie in the introduction of improved varieties of plants. In the case of coffee the Arabian types that were bringing the highest prices in the United States were imported in seed from Java. These were found to be liable to the diseases and suffered from the attack of insects that afflicted the type of Arabian coffee that had been grown for years in Porto Rico. Moreover, when grown under local conditions of soil and climate, most of these coffees approximated the flavor and aroma of the Porto Rico coffee and fitted into the same trade.

Later, certain types of the Liberian group of coffees were introduced by the station and some were found more vigorous than the Arabian types, gave larger yields and were resistant to the attacks of certain insects as the leaf miner.

In the work with coffee during the quarter century just passed the following points were stressed: The coffee planter must diversify his crops where possible. Varieties of coffee more resistant to disease and insect pests must be sought. A rational plan of fertilizing the coffees must be worked out for the different types of soil. All growers should co-operate with the object of selling their produce in its best market.

In 1904 the station made the first importation of sugarcanes. Among the lot were Yellow Caledonia, White Bamboo, Tibboo Merd (very like Cristalina), Demerara 74, 95 and 117, and Trinidad 77. Later importations were made annually and the station shortly began breeding new varieties which were exchanged with other countries carrying on similar lines of work.

The new canes were carefully propagated at the station and when of outstanding merit and free from disease and resistant to insect attack were distributed in small amounts to planters. Some were found better adapted to certain soils than others. Our planters were very much alive to the merits of these canes on their plantations. Desirable varieties were rapidly propagated and sold for seed purposes. To the skill and perseverance of representative planters in various regions were due the rapid changes brought about in substituting the varieties of cane when a better one appeared in the plots of the experiment station. When the mosaic disease appeared and was rapidly devastating the fields, the station imported an immune cane that saved the industry, but its rapid dissemination was due to the planters who sold all the crop at 8 months for planting purposes. The fact that this cane tillered very profusely, there sometimes appearing 80 stalks in the hill, lent itself very readily to its rapid increase.

The total immunity of this cane to mosaic led to its incorporation in some proportion in crossing varieties in our cane breeding work. The percentage in the progeny necessary to carry immunity is not yet fully determined but its capacity in this regard is remarkable.

No single factor is doing more for sugar production than the improvement of varieties by breeding. Not only are higher-producing canes being developed but those so resistant to disease as to result in some cases in the virtual salvation of the industry.

Another important point in cane growing is the study of the soil. The experiment station has made many experiments in fertilizing cane but the soils in different sections of the Island vary to such an extent as to make their wide application of doubtful value. It is necessary that each plantation apply the various methods of soil testing and the application of fertilizers locally in order to determine the relative values of methods and amounts of fertilizer to be applied for maximum profitable returns.

From a beginning 26 years ago the fruit industry has grown into one of the leading industries of the Island, the shipments reaching several million dollars annually and with a greater future assured. In this expansion the experiment station may claim a creditable part.

Instead of cutting down the wild orange trees on the coffee plantations, the planters are now fostering them as part of the annual income. Budded fruit is being planted, both oranges and grapefruit, while some lesser-known fruits are under trial as a source of possible added income to the planter.

At this time fruit growing is a very promising industry in Porto Rico although it is still largely in an experimental stage for many kinds and types. It is probably ultimately destined to be our leading agricultural industry. To-day it is making greater progress than any other. It is not only adding to the wealth of the planter but is giving employment to labor and that throughout a longer period of the year.

During the 26 years under review there has been steady improvement in the live stock of the Island. The station has imported horses, cattle, goats, pigs, and poultry for its own use and for planters in various sections of the Island.

The horse has been employed but little in field work in Porto Rico. The first importations were probably small-sized animals. Their descendants lack size and strength for heavy work. The automobile has supplanted them in the coach and heavy trucking. Horses are still used on the plantations for riding and as beasts of burden on the mountain trails. Only a change in economic conditions will again increase their use.

Cattle for centuries have been the draft animals in Porto Rico. They have maintained a vigorous and muscular frame. Their faults have been low milk yields and late maturity. However, they are here and are the foundation stock upon which we must build a better race.

In improving cattle we should first select for crossing a breed that carries the desired characteristics. In Porto Rico we need first a milk-yielding breed above all else. Then should follow early maturity, size and ability to work and adaptability to a climate which is warm throughout the year. In our own experiments and by observation of the experience of our planters we are of the opinion that the Guernsey is the breed that comes nearest meeting the above requirements. Moreover, the Guernsey approaches the type of the Porto Rican cattle, and the crosses between the two are more symmetrical and less liable to show undesirable characteristics as to form than appear in the crosses of the Porto Rican cattle with other breeds.

The registered Guernseys on the Island outnumber those registered of any other breed. We should look forward to the time when we shall have a pure-bred race of cattle on the Island, all registered and the breed carried on to that degree of efficiency attained by the breed in the island of its origin and elsewhere.

The pig is the profitable product of wastes. Aside from those of the household there are few wastes in Porto Rico that are available for pig feeding. Until manufactures or diversified farming find a food for pig-feeding there is little likelihood of a great increase in these animals. Under present conditions we can import pork products at a less cost than we can produce them.

The greatest lack throughout the country in Porto Rico is improved poultry. There are drawbacks to growing poultry but they can be overcome. The greatest lack in poultry raising is home-grown feed; the greatest pests, the rat, the mongoose and thieves; the worst diseases, chicken pox and roup. There are favorable conditions enough to warrant Porto Rico

being an exporter rather than an importer of poultry products.

For forage the station has introduced a number of grasses that are grown successfully in other countries. Of these, Elephant, Guatemala and Uba cane give the largest yields and are now found all over the Island, and for grazing purposes the molasses grass has given best results. Others are under trial.

For a leguminous forage the velvetbean is the easiest-grown and gives the greatest amount of forage cut for feed. Slow-growing legumes as clovers can not establish themselves in competition with rank-growing grasses especially in the areas of greatest rainfall.

The station has distributed tons of seed of the non-saccharine sorghums and found them to grow well in most sections. They are recommended especially as feed for poultry. They should supplant some of the grains imported for our dairy cattle. They are especially productive in the dry sections in the summer months.

Twenty-six years ago the farm labor wage was 50 cents per day, nothing furnished unless a building site for a small shack. There has been an increase in wages since that time of 50 to 100 per cent. On the coffee plantations the amount of work done has shown but little, if any, increase. The population on the plantations has grown steadily. The proper care and nourishment of the laboring classes in the interior is the acute problem of Porto Rico. The steady increase of population on a soil showing steadily diminishing returns is acute. The station has found and introduced some feed crops that have added to the well-being of the rural laborer but to find a money crop that will give him employment and wages that will buy the necessary imports that he needs is difficult. The lands devoted to coffee are showing smaller yields. Their situation is such that because of inaccessibility and distance from markets few other crops are possible. This renders the question of diversification one of difficult solution.

The appropriations for the experiment station during the years under review have been small and for the greater part made by the Congress of the United States. The Insular Government made a few special appropriations in the early years of the station for land, drainage and buildings. Later its policy has been to maintain its own station rather than to increase and strengthen the work of the Federal station.

Of later years the station has had not only to finance its steadily increasing experimental work but to provide buildings and equipment to care for it. This has rendered necessary the most strict economy. For example, buildings have been erected by farm labor, using it during slack periods as the dry season. Also certain local building materials have been employed, and valuable data secured as to their availability and economy in a country where the natural resources have been very completely sapped.

